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TITLE: Minutes of the Explosives Safety Seminar (22nd) Held in Anaheim, California on 26-28 August 1986. Volume 1.

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FRICTION AND IMPACT SENSITIVITIES FOR HIGH EXPLOSIVES

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Understanding sensitivities of energetic materials under specific initiation modes is critical for

- Safe handling and accident prevention during development, production, transportation, and storage.

- Material's design application.

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Two major approaches have to be considered in planning for safe handling of energetic materials:

- Establish the necessary conditions to prevent a premature initiation.

- Limit the degree of personnel and property damage that would result if an accident were to occur.

cont'd

A premature initiation could be caused by one or a combination of the following:

- Impact;
- Friction;
- Electrostatic discharge;
- Heat, etc.

Samples tested:

CP - 2-(5-cyanotetrazolato)pentaammine cobalt (III);

PETN - pentaerythritol tetranitrate;

Barium styphnate;

HMX - cyclotetramethylene tetranitramine;

TATB - 1,3,5-triamino-2,4,6-trinitrobenzene

LX-15 - 95 wt % HNS-I and 5 wt % Kel-F800

LX-16 - 96 wt % PETN and 4% FPC-461

RX26BB - 50 wt % HMX and 50 wt % TATB

RX26BH - RX26BB with a 0.1 wt % each of calcium stearate and graphite; and

PBX of HMX - 96 wt % HMX and 4% FPC-461

Sample parameters:

- Various surface area
- Baking effect
- Aging effect
- Batch difference

The load charges of 50% probability initiation were calculated from the Bruceton one-shot (up-and-down) statistics.

An Example of Bruceton Data for Friction Sensitivty Test (LX-16, ER 7364)

Weight Charge (kg)	Test Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
8.8		X						X		X										X		X		X
8.0	O		X		X		O		O		X		X		X				O		O		O	
7.2				O		O						O		O		X		O						
6.4																	O							

50% probability: 7.7 kg

FRICTION SENSITIVITY

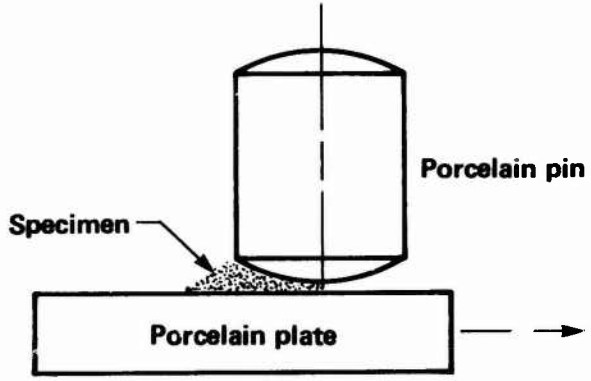
A large BAM (Bundesanstalt fur Materialprufung) tester was used for friction tests.

- Six different positions in the tester's arm.

- Weight charge from 0.5 to 36 kg.

Friction test parameters:

- 0.010 g sample used each time.
- Porcelain plate and pin of "standard roughness."
- A path of 10 mm length.



FRICTION SENSITIVITIES OF PETN AND HMX

Explosives	Weight Charge for 50% Probability (kg)	Sample Characteristics
HMX	6.2	6320 cm^2/g surface, before baking
HMX	6.1	6320 cm^2/g surface, after 100 hr at 100°C
PBX of HMX	6.1	96 wt % of 6320 surface after 100 hr at 100°C and 4 wt % FPC-461
PBX of HMX	7.2	96 wt % of a 930 cm^2/g HMX and 4 wt % PFC-461
PETN	8.1	4110 cm^2/g surface area
PETN	7.0	31,000 cm^3/g surface area
LX-16	7.7	96 wt % 4110 cm^2/g PETN and 4 wt % FPC-461

CONCLUSIONS FOR PETN AND HMX FRICTION SENSITIVITIES

- HMX is slightly more sensitive than PETN.
- Powders of higher surface area are more sensitive to friction than those of the lower surface area.
- Coating with 4 wt % FPC-461 has no effect on friction sensitivity.
- Baking 100 hr at 100°C has no effect on friction sensitivity.

FRICTION SENSITIVITIES OF CP, BARIUM STYPHNATE, TATB, AND LX-15

Explosives	Weight Charge for 50% Probability (kg)	Sample Characteristics
CP	0.9	Unidynamics EL58633
CP	1.3	Unidynamics EL47344
Barium Styphnate	1.7	Chemtronics
Barium Styphnate	2.0	Sandia
LX-15	>36	95 wt % HNS-I and 5 wt % Kel-F800, larger crystal
LX-15	>36	Fine powders
TATB	>36	LLNL-B-592
RX26BB	13	50 wt % TATB and 50 wt % HMX
RX26BH	>36	RX26BB with 0.1% graphite and 0.1% calcium stearate

CONCLUSIONS OF FRICTION SENSITIVITIES FOR CP, BARIUM STYPHNATE, TATB, AND LX-15

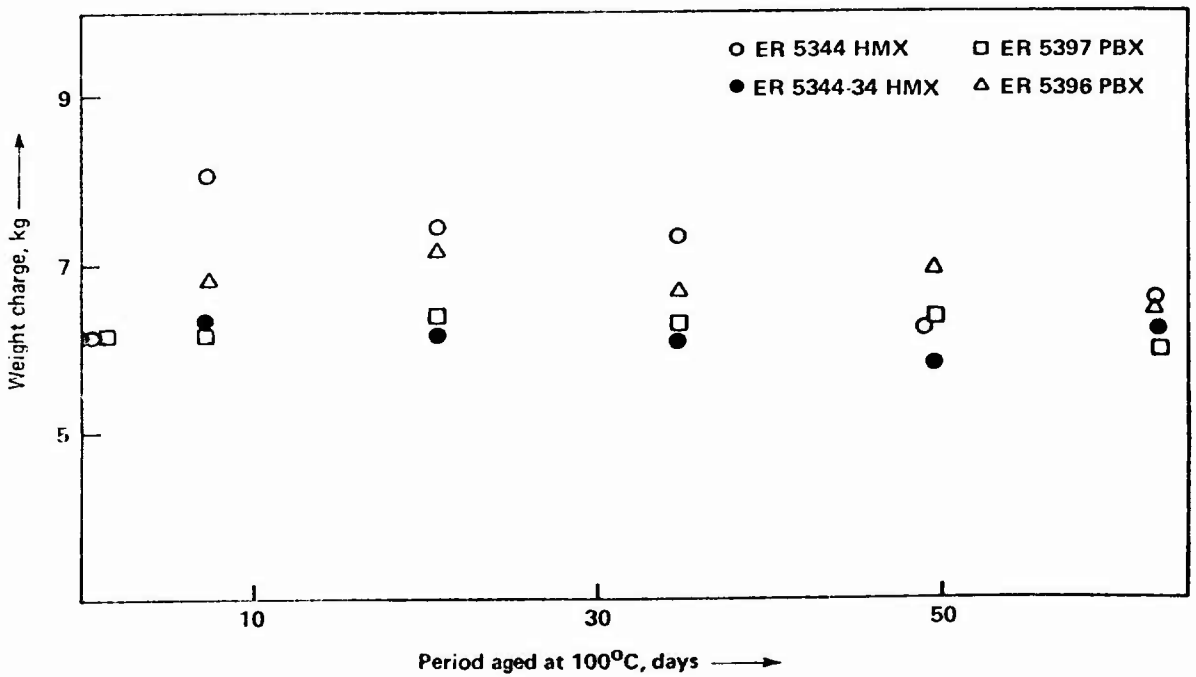
- Compared to PETN and HMX, CP and barium styphnate are very friction sensitive, while TATB and LX-15 are insensitive.

- Mixture of TATB and HMX (which is friction sensitive) is more friction sensitive than TATB.

- Blending of this mixture to 0.1% graphite and 0.1% calcium stearate reduces friction sensitivity.

- Batch-to-batch variations.

No effects on impact or friction sensitivities were observed for HMX and its PBX'es after aged at 100°C up to 9 weeks.



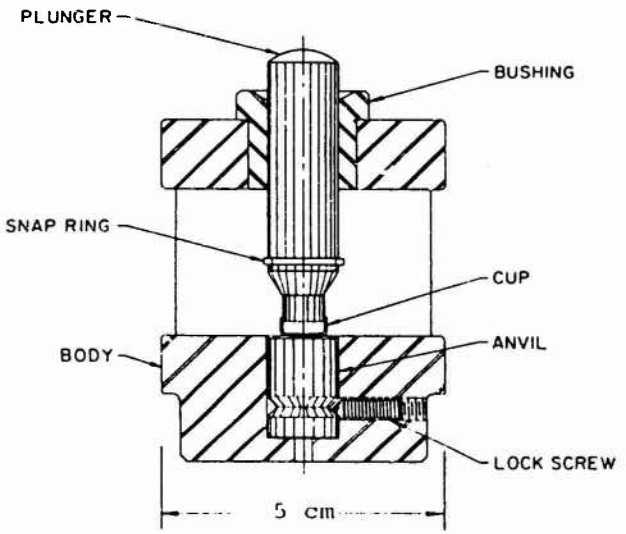
IMPACT SENSITIVITY

A Technoproducts drop-weight tester was used for impact sensitivity tests.

- Drop height: 0 to 50 cm in 0.5 cm increments.
- Weight charge: 1 to 5 kg in 0.1 kg increments.

Impact test parameters:

- 0.020 g sample each test
- Always dropped from 50 cm height
- Results tabulated in cm-kg.



SOLID SAMPLE HOLDER

IMPACT SENSITIVITIES OF PETN AND HMX

Explosives	Weight Charge for 50% Probability (kg - cm)	Sample Characteristics
HMX	160	6320 cm^2/g surface, before baking
HMX	176	6320 cm^2/g surface, after 100 hrs. at 100°C
PBX of HMX	178	96 wt % 6320 surface after 100 hrs. at 100°C and 4 wt % FPC 461
PBX of HMX	170	96 wt % of a 930 cm^2/g HMX and 4 wt % FPC 461
PETN	124	4110 cm^2/g surface area
PETN	170	31000 cm^2/g surface area
LX-16	120	96 wt % 4110 cm^2/g PETN and 4 wt % FPC 461

Conclusion for PETN and HMX Impact Sensitivities

- Powders of higher surface area (lower crystal size) are less impact sensitive than those of lower surface are (longer crystal size).
- Impact sensitivities of PETN and HMX are comparable.
- Baking 100 hrs. at 100°C has no effect in impact sensitivity (?).
- Coating with 4 wt % FPC 461 has no effect in impact sensitivity.

IMPACT SENSITIVITIES OF CP, BARIUM STYPHNATE, TATB, AND LX-15

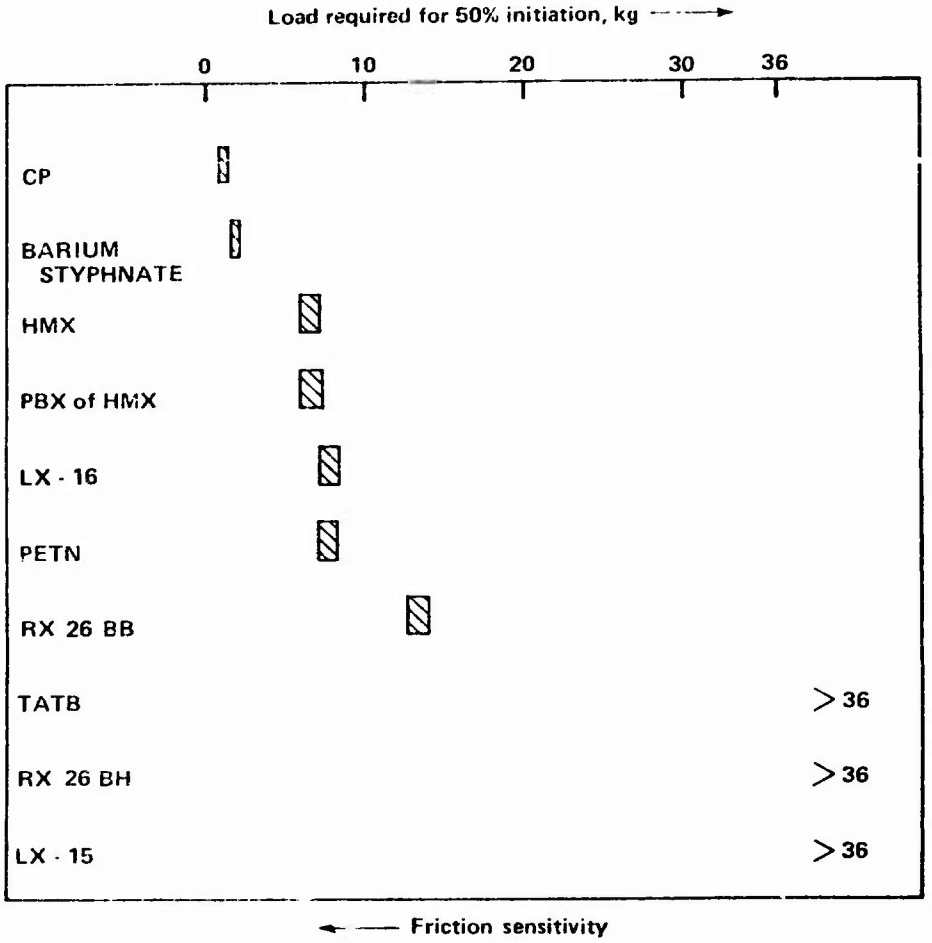
Explosives	Weight Charge for 50% Probability (kg - cm)	Sample Characteristics
CP	66	Unidynamics EL58633
CP	105	Unidynamics EL47344
Barium Styphnate	113	Chemtronics
Barium Styphnate	122	Sandia
LX-15	>250	95 wt % HNS-1, 5 wt % Kel-F 800, larger crystal
LX-15	>250	Fine powders
TATB	>250	LLNL-B-592
RX26BB	>250	50% TATB & 50% HMX
RX26BH	>250	12X26BB with 0.1 % graphite and 0.1% calcium stearate

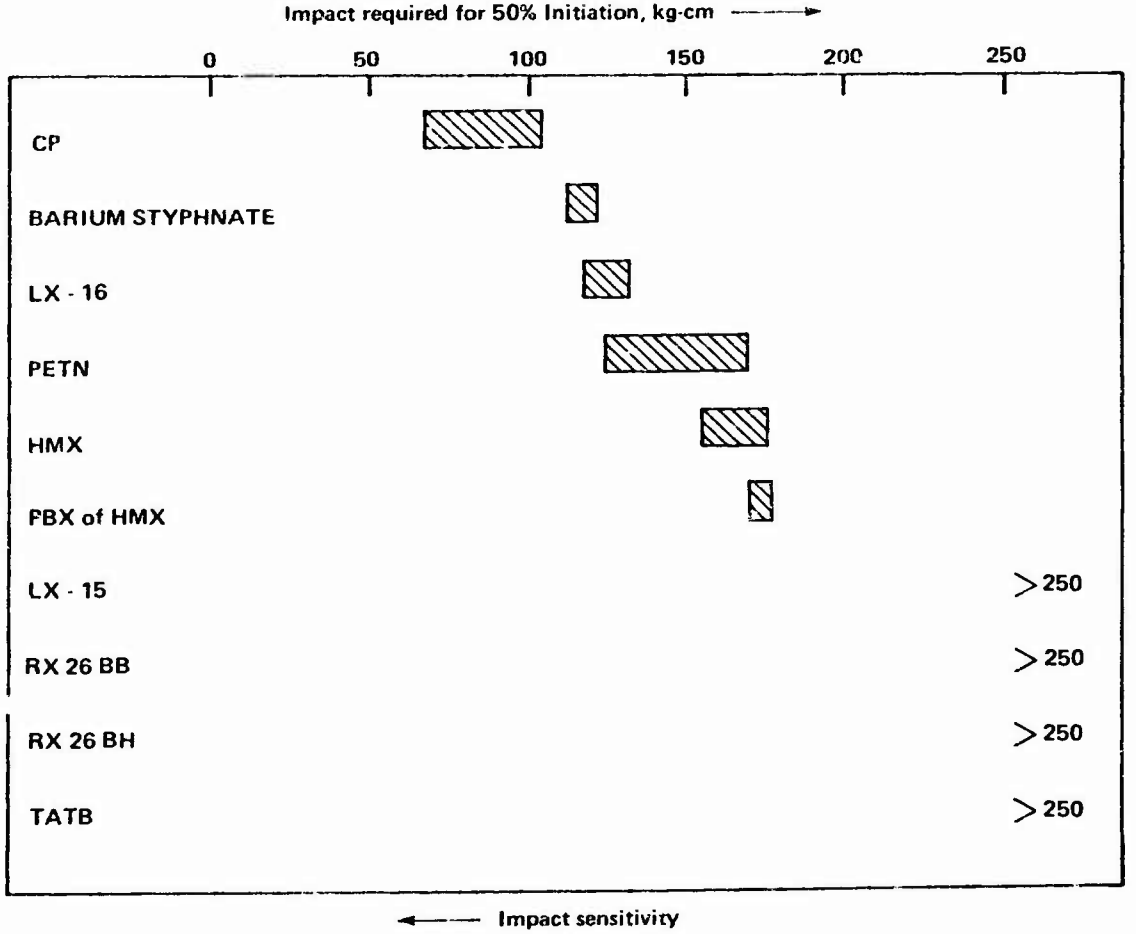
Conclusion for Impact Sensitivities for CP, Barium Styphnate, TATB, and LX-15

- Comparing to PETN and HMX, CP and barium styphnate are very sensitive to impact while TATB and LX-15 are insensitive.
- TATB, LX-15, RX26BB, RX26BH are all out of our test range.
- Batch-to-batch variations.

SUMMARY

- Results for comparative study.
- Both impact and friction sensitivities are surface area dependent.
- No effects by aging (or baking) at 100°C for up to 9 weeks.
- No effects by coating 4 wt % FPC 461.
- Batch-to-batch variations.


Load required for 50% initiation, kg
0
10
20
30
36
CP
BARIUM STYPHNATE
HMX
PBX of HMX
LX - 16
PETN
RX 26 BB
TATB
> 36
RX 26 BH
> 36
LX - 15
> 36
Friction sensitivity


Impact required for 50% Initiation, kg-cm
0
50
100
150
200
250
CP
BARIUM STYPHNATE
LX - 16
PETN
HMX
PBX of HMX
LX - 15
> 250
RX 26 BB
> 250
RX 26 BH
> 250
TATB
> 250
Impact sensitivity